(12) UK Patent Application (19) GB (11) 2 201 216 (13) A

(43) Application published 24 Aug 1988

(21) Application No 8717433

(22) Date of filing 23 Jul 1987

(30) Priority data
(31) 8704095 (32) 21 Feb 1987 (33) GB

(51) INT CL⁴
F16B 39/22

(52) Domestic classification (Edition J):
F2H 13F1 13F5 15C CG KX

(56) Documents cited
GB A 2041139 GB 0583972 GB 0576258
GB 0564228 GB 0554555 GB 0502477

(58) Field of search
F2H
Selected US specifications from IPC sub-class
F16B

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(54) Locking of screw threaded fasteners

(57) A nut 12 is provided with a conical end 13 which is slotted so that when engaged in a conical recess 19 in a washer 17 (or a further nut or a workpiece tightening of the nut 12 onto a threaded shaft (not shown) causes radial compression of the nut 12 within its elastic limit to produce locking of the nut 12. The cone angle of the recess 19 is greater than that of the nut end 13.

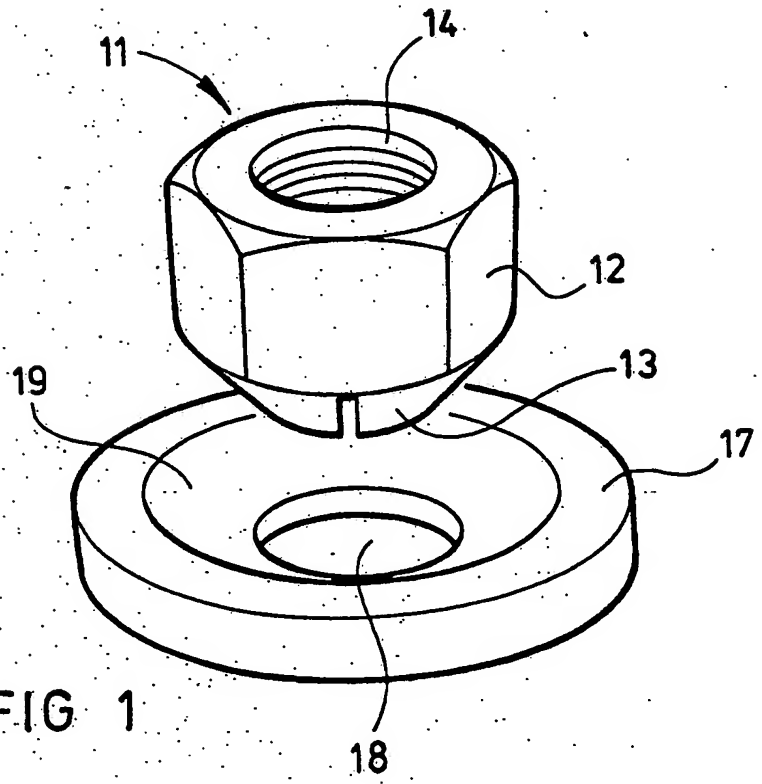

FIG 1

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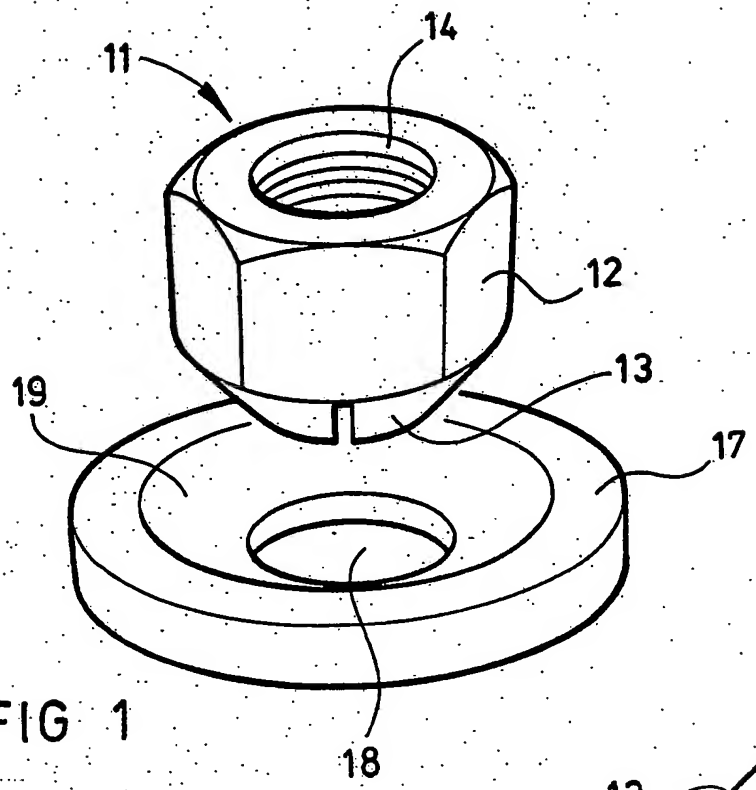

FIG 1

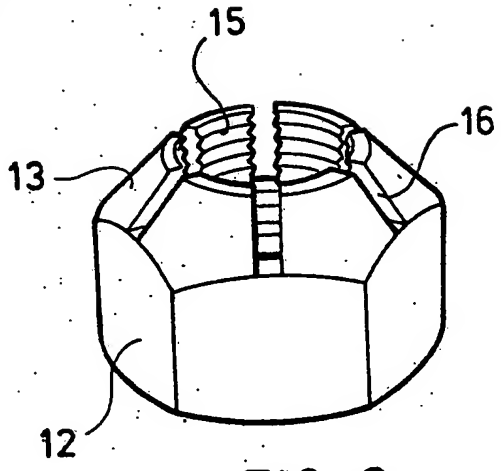

FIG 2

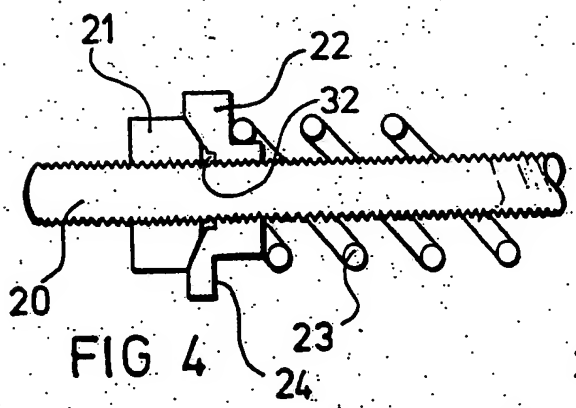

FIG 4

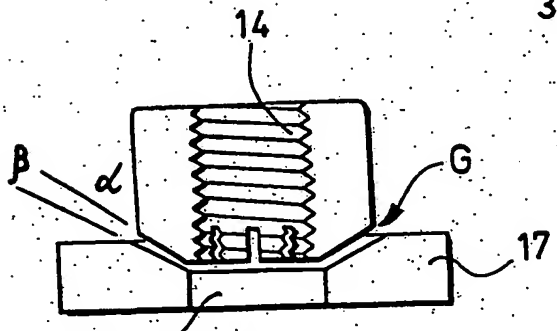

FIG 3

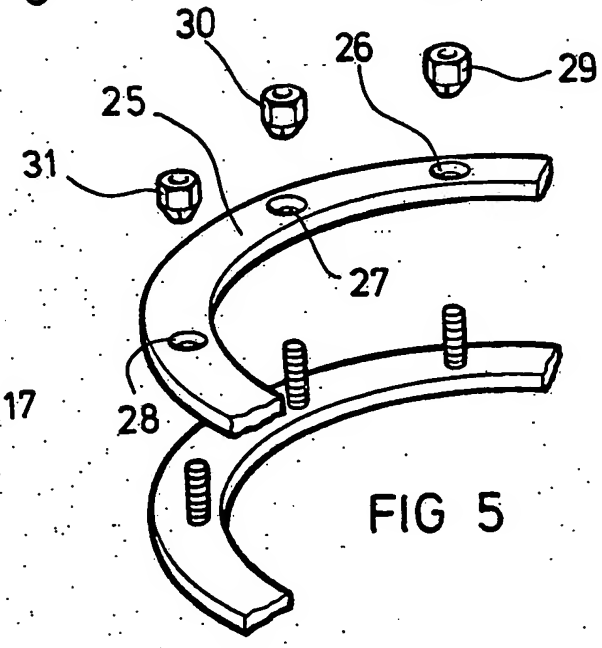

FIG 5

IMPROVEMENTS IN OR RELATING TO FASTENING MEANS

The present invention relates generally to fastening means and particularly to screw threaded fasteners.

A major problem experienced when components are secured together by screw threaded fasteners is the fact that vibration or shocks and knocks experienced in use can tend to cause these to become loosened to the point where the components fixed by such fasteners can move in relation to one another and/or the fastener may become entirely undone allowing the components fixed thereby to separate, all this with serious, and sometimes with disastrous consequences.

To overcome this problem various techniques have been employed in the prior art. The most common of these is the use of so-called "spring" washers which are washers made of spring steel to a single turn helical conformation with a split offering a sharp cutting edge at each end of the turn. Upon compression of the spring washer axially by tightening a nut onto a screw threaded shaft or stud the corner portions are pressed tightly against the mating faces of the component and the nut and, in theory at least, any tendency of the nut to come unscrewed is resisted by the ends of the spring washer biting into the mating faces. Such spring washers are serviceable in certain circumstances but do not offer an entirely satisfactory degree of security. A more secure fastening is provided by the so-called "self-locking" nuts which are nuts having inserts of plastic material which is cut into and plastically deformed upon screwing the nut onto a cooperating threaded male member such as

a bolt, shaft or stud. Again, the degree of security is not absolute and a major disadvantage of such nuts is that if they have to be deliberately released for maintenance purposes they cannot be re-used since the plastic deformation can only be effected once.

Absolute security against loosening by vibration is provided by the so-called "castle" nuts if these are used in combination with a threaded male member having a transverse passage or opening. A "castle" nut is one having castellations on one face resulting in the provision of aligned transverse channels which can receive a locking pin or wire which passes through the transverse passage or hole in the male member. A disadvantage of such castle nuts lies in the fact that the nut can only be tightened in incremenets of one-sixth of a turn between successive positions where the castellation channels are aligned with the hole in the stud, and there is only a limited axial range over which the castellations and the hole in the stud are aligned as well so that such an arrangement is not appropriate for general purpose use. It also has the further disadvantage of requiring additional time and care in making and releasing the fastening due to the necessity of introducing a safety pin or wire through the hole and in securing this by twisting the ends of the wire or by plastically deforming the crevice.

Other prior art attempts to solve the vibration problem include plastic deformation of the threads of a stud after tightening, and likewise, plastic deformation of a nut. Such plastic deformation is a disadvantage in itself, however, since it involves overstressing the

threaded fastening and, as in the case of self-locking nuts, its use means that the fastening can only be used once and must be discarded if deliberately released for maintenance purposes.

The present invention seeks to provide a screw fastener which is re-usable and which is nevertheless self-locking to resist release inadvertently caused by vibration or shocks to which the fastening may be subjected during its service life. The present invention also seeks to provide a screw fastening in which the self-locking action is achieved by elastic rather than plastic deformation so that the fastening is re-usable many times without risk of its self locking properties being reduced.

According to one aspect of the present invention, therefore, screw threaded fastening means comprise a component with a threaded opening and a tapered end portion, and a cooperating member having a recess into which the said conical end portion can be introduced upon fastening of the component and the cooperating member, there being a plurality of substantially radial slots in the said tapered end portion such that when the said component is screwed onto a threaded shaft (or other male member) projecting from or through the said cooperating member the said tapered end portion is radially compressed, within its elastic limit, by its engagement in the said recess.

In a preferred embodiment of the invention the said tapered end portion is a substantially conical end face and the recess in the cooperating member is also substantially conical. For the most accurate self-locking arrangement to be provided the said substantially conical recess in the said cooperating member preferably has a cone angle which is slightly greater (that is by a few degrees) than the cone angle of the said conical end portion of the said component such that upon elastic radial compression of the said conical end portion as it is pressed into the conical recess the conical facing surfaces can be brought into substantially exactly matching face to fact relationship. This maximises the frictional engagement between the two faces, which is maintained by the elastic stresses exerted by the deformation of the conical end portion of the said component.

For general purpose use the said component may be a nut which can be screwed onto a threaded shaft or stud, or onto one end of a bolt. For special purpose use, on the other hand, the said component may be any member having a threaded hole which is intended to receive a threaded male element such as a set screw. In the former case the said cooperating member may conveniently be a washer having a central through-hole formed at the bottom of the said conical recess.

In this case the said nut preferably has a hexagonal cross section with six generally flat faces defining a hexagonal prismatic body having an axially extending screw threaded through-hole also passing through a said conical end portion and also threaded in this portion.

The said radially extending slots are, then, preferably formed only in the said conical end portion and each lies perpendicularly with respect to a respective face of the said hexagonal prismatic body, diametrically opposite slots being aligned with one another.

To increase the frictional contact between the facing surfaces, the conical faces of the said recess in the cooperating element and the conical end portion in the said component may have a surface treatment or surface working such as to increase the frictional contacts therebetween.

Embodiments of the present invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of a nut and cooperating washer formed as a first embodiment of the present invention;

Figure 2 is a perspective view of the nut illustrated in Figure 1, shown in an inverted position with respect to that illustrated in Figure 1;

Figure 3 is an axial cross section through the nut and washer of Figure 1 showing these in the closely approached position immediately prior to elastic deformation;

Figure 4 is an axial section through a second embodiment of the invention; and

Figure 5 is a schematic partial perspective view of an assembly incorporating fasteners formed as embodiments of the present invention.

Referring now to the drawings, the first embodiment

shown in Figures 1 and 2 is a nut and cooperating washer for general purpose use. The description of this embodiment of the invention for general use is exemplary only and no loss of generality is engendered thereby. The present invention may therefore be applied in many different ways and the scope of the invention is not to be taken as limited by the followisng description of a preferred specific embodiment.

The nut shown in the drawings comprises a generally hexagonal prismatic body 12 having a conical end portion 13 and a threaded hole 14 which passes right through the nut and is provided with a screw thread 15 over the whole of its length including the part which passes through the conical end portion 13.

In the conical end portion 13 are formed three pairs of aligned radial slots 16 the axial extent of which does not exceed that of the conical end portion 13.

Cooperating with the nut 11 is a washer 17 having a centre through-hole 18 at the bottom of a conical recess 19 concentric with the washer 17 itself. The cone angle α of the conical end portion 13 of the nut 11 is slightly less than the cone angle β of the conical recess 19 in the washer 17 as illustrated clearly in Figure 3.

In use of the fastening illustrated in the drawings the washer 17 is placed against the flat face of a componennt to be fixed and a threaded male member such as a bolt or stud is passed therethrough and onto it the nut 11 is screwed with the conical end portion 13 facing the conical recess 19 in the washer 17. When the two

conical faces 13,19 meet further tightening of the nut 11 will cause elastic deformation of the conical end portion 13 thereby radially inwardly pressing the screw thread 15 of the hole 14 ever more tightly against the corresponding screw thread of the male member thereby taking up any slack and eventually creating a high frictional resistance between these components. The limit of this movement is reached when the elastic deformation of the conical end portion 13 has caused the conical face to adopt a cone angle β matching that of the conical recess 19.

This can also be used to apply a predetermined axial torque since the elastic deformation characteristics of the nut 11 can be tested on a trial sample and published with the sale of the nuts. Tightening of the nut 11 onto a stud until the gap G visible between the conical end portion 13 of the nut 11 and the flat face of the washer 17 is entirely closed will signify the attainment of a predetermined torque.

Variations in the degree of resistance to radial deformation can be achieved by various means. For example, the slots 16 may be aligned with the junction line between adjacent faces of the hexagonal nut, rather than aligned with the centre of each face as illustrated in the drawings. Further, the width of the slots may be varied to leave more or less material between adjacent slots. Obviously, the wider the slots the less resistant the nut is to radial deformation, and consequently the smaller the torque which must be applied in order to secure locking. This may be important when dealing with large steel nuts for fixing

components of heavy equipment such as earth moving or excavating equipment, mining and quarrying equipment and the like, since very large fastenings are required for such components, and the torque forces required to effect radial deformation of a large nut would be very considerable. Further, for small and light nuts not only may the slots 16 be narrower but there may be fewer than those illustrated. Correspondingly, if it is required to reduce the radial resistance further a greater number of slots may be provided as long as the material between adjacent slots retains sufficient rigidity to accommodate the circumferential forces experienced upon tightening of the nut without being subjected to substantial helical deformation.

It will also be apparent that the invention can be applied to screw fastenings made in any material capable of exhibiting elastic deformation, and non-limitative mention here may be made of the most common materials used for screw fastenings, namely steel, brass, aluminium and plastics materials.

The fastening assembly illustrated in Figure 4 is similar to that illustrated in Figures 1 to 3, comprising a threaded shaft 20 onto which is screwed a nut 21 identical in all respects to the nut 12 illustrated in Figures 1 to 3. This nut cooperates with a washer 22 in many respects similar to the washer 17 of Figures 1 to 3, but differing in that its aperture 18 is threaded allowing it to be screwed on to the shaft 20 into cooperative engagement with the nut 21. For this purpose the washer 22 has two parallel, diametrically opposed flats (not shown) to facilitate gripping by a

spanner for turning it. The washer 22 further has a recess 32 at the radially inner rim of the conical recess to ensure that the end of the nut does not foul against the threads in the aperture in the assembly illustrated in Figure 4 axial tension is applied to the shaft 20 via a spring 23 which may then react, in a manner not shown, against a cooperating component to which the threaded shaft 20 is attached, for example, in the form of a stud by screwing, or through an aperture in a cooperating component. It will be noted that the washer 22 is somewhat thicker than the washer 17 of the embodiment of Figures 1 to 3 in order that the aperture therein may be threaded with enough turns to enable it to grip securely, and further is provided with an annular rebate or shoulder 24 to receive and locate the end of the spring 23.

In an alternative embodiment (not illustrated) the nut 12 or 21 may be formed as a domed nut closed at its end opposite the conical portion 13, for receiving the free end such as the shaft 20 without leaving any part exposed. Such domed or crowned nuts are useful in circumstances where external contact with the fastening may be a hazard to personnel.

Fastening assemblies may also be formed in which a plurality of nuts, such as the nut 12 or a nut 21 are fixed to a common component having a plurality of conical recesses. An example of this is shown in Figure 5, in which the "cooperating member" is formed as an annular member 25 having a plurality of holes 26, 27, 28 therethrough (apart, that is, from the main central aperture) each having a corresponding conical recess 32,

33, 34 for receiving a respective nut 29, 30, 31 each secured in the manner described in relation to Figures 1 to 3 within a respective recess 32, 33, 34 to a respective stud 35, 36, 37 passing through a respective hole 26, 27, 28 in the member 25.

CLAIMS

1. Screw threaded fastening means comprising a component with a threaded opening and a tapered end portion, and a cooperating member having a recess into which the said conical end portion can be introduced upon fastening of the component and the cooperating member, there being a plurality of substantially radial slots in the said tapered end portion such that when the said component is screwed onto a threaded shaft projecting from or through the said cooperating member the said tapered end portion is radially compressed within its elastic limit by its engagement in the said recess.

2. Screw threaded fastening means as claimed in Claim 1, in which the said tapered end portion is substantially conical and the recess in the cooperating member is also substantially conical.

3. Screw threaded fastening means as claimed in Claim 2, in which the said substantially conical recess in the said cooperating member has a cone angle which is slightly greater than the cone angle of the said conical end portion of the said component such that upon elastic radial compression of the said conical end portion as it is pressed into the said concial recess the conical facing surfaces can be brought into substantially exactly matching face-to-face relationship.

4. Screw threaded fastening means as claimed in any preceding Claim in which the said component is a nut which can be screwed onto a threaded shaft or stud.

5. Screw threaded fastening means as claimed in any of Claims 2,3 or 4, in which the said cooperating member is a washer having a central through hole formed at the bottom of the said conical recess.

6. Screw threaded fastening means as claimed in Claim 4 or Claim 5, in which the said nut has a hexagonal cross section with six generally flat faces defining a hexagonal prismatic body having an axially extending screw threaded through hole also passing through the said conical end portion and also threaded in this portion.

7. Screw threaded fastening means as claimed in Claim 6, in which the said radially extending slots are formed only in the said conical end portion and each lies perpendicularly with respect to a respective face of the said hexagonal prismatic body.

8. Screw threaded fastening means as claimed in any preceding Claim, in which the component is a member to which the cooperating element is to be fixed for example by means of a set bolt.

9. Screw threaded fastening means as claimed in any preceding Claim in which the conical faces of the said recess in the cooperating element and the conical end portion in the said component have a surface treatment or surface working such as to increase frictional contact therebetween.

10. Screw threaded fastening means as claimed in any preceding Claim, in which the said cooperating member is

itself provided with an opening having an internal screw thread.

11. Screw threaded fastening means as claimed in Claim 10, in which the said cooperating member is axially biased by a spring into contact with the said component.

12. Screw threaded fastening means substantially as hereinbefore described with reference to and as shown in the accompanying drawings.

13. A fastening assembly incorporating a plurality of screw threaded fastening means as claimed in any preceding Claim.

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